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Sub-slab vs. Near-slab Soil Vapor Profiles at a Chlorinated Solvent Site

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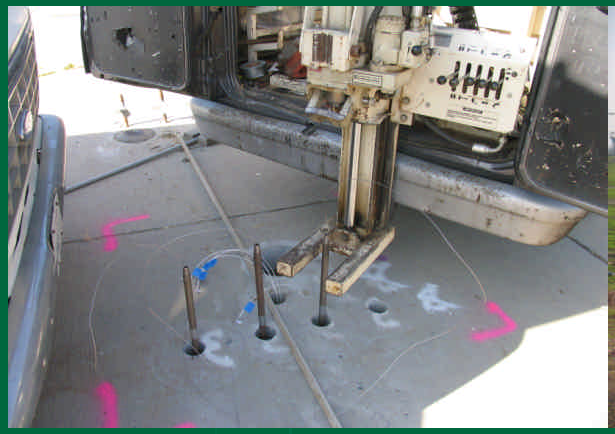

Office of Research and Development, National Exposure Research Laboratory,
Environmental Sciences Division, Environmental Chemistry Branch, Las Vegas, Nevada

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Introduction

- Project Sponsor: EPA/ORD, National Exposure Research Laboratory in Las Vegas, NV

- Objective: Measure vapor concentration profile and compare to general model predictions

- Approach:
  - locate a host site with a groundwater source of VOCs, preferably chlorinated solvents
  - install a series of nested soil vapor probes spaced out over sub-slab and near-slab area

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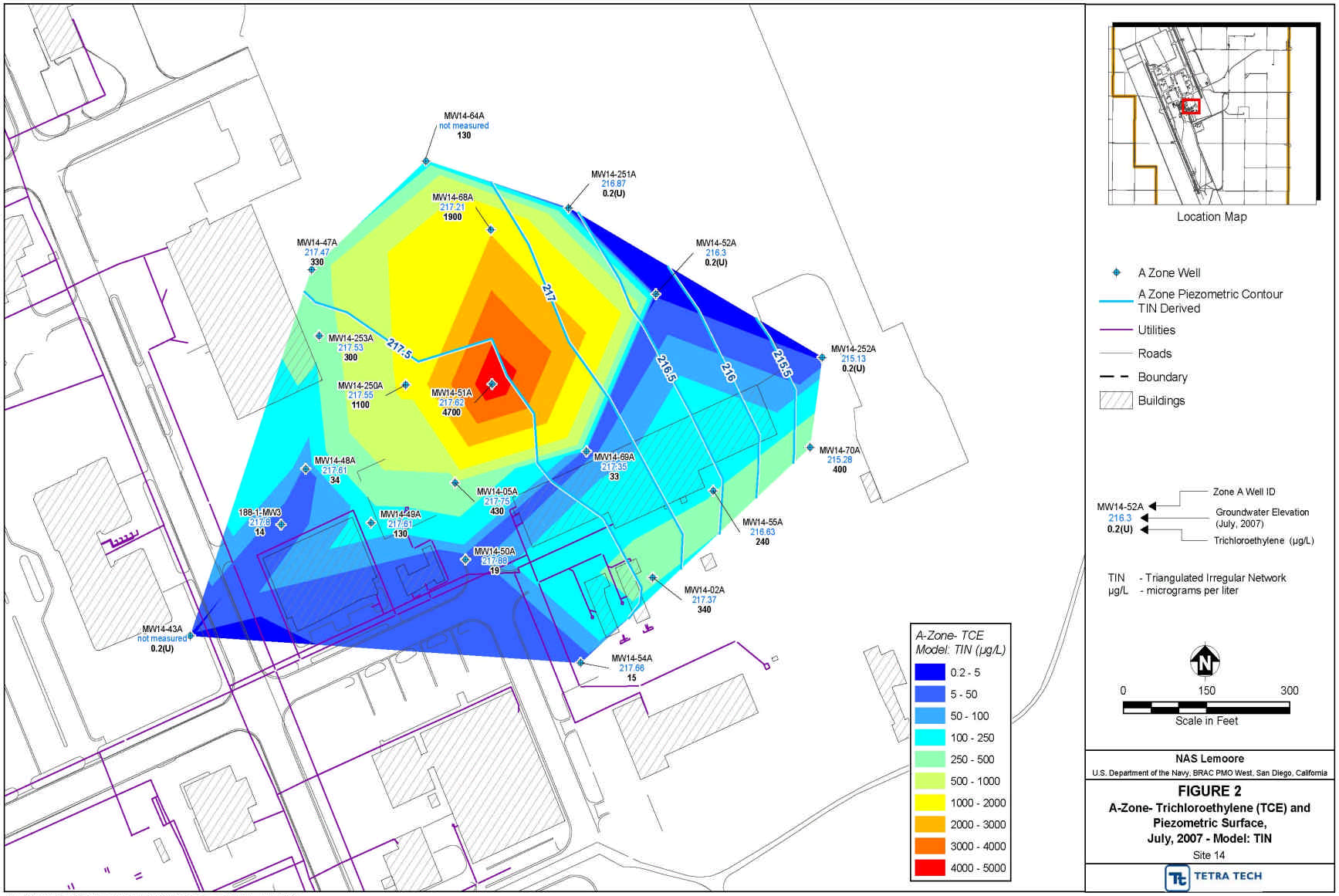
NAS Lemoore IRP Site 14

- Interbedded fine- and coarse-grained deposits above the “A” clay @ 45 ft bgs
- Groundwater at 10 to 12 ft bgs
- Large TCE/PCE plume in groundwater from multiple historical releases
- Slow-moving groundwater and aerobic aquifer (no biodegradation)



NAS Lemoore

U.S. Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 2

A-Zone- Trichloroethylene (TCE) and Piezometric Surface, July, 2007 - Model: TIN

Site 14

TETRA TECH

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Location of Sampling Transects

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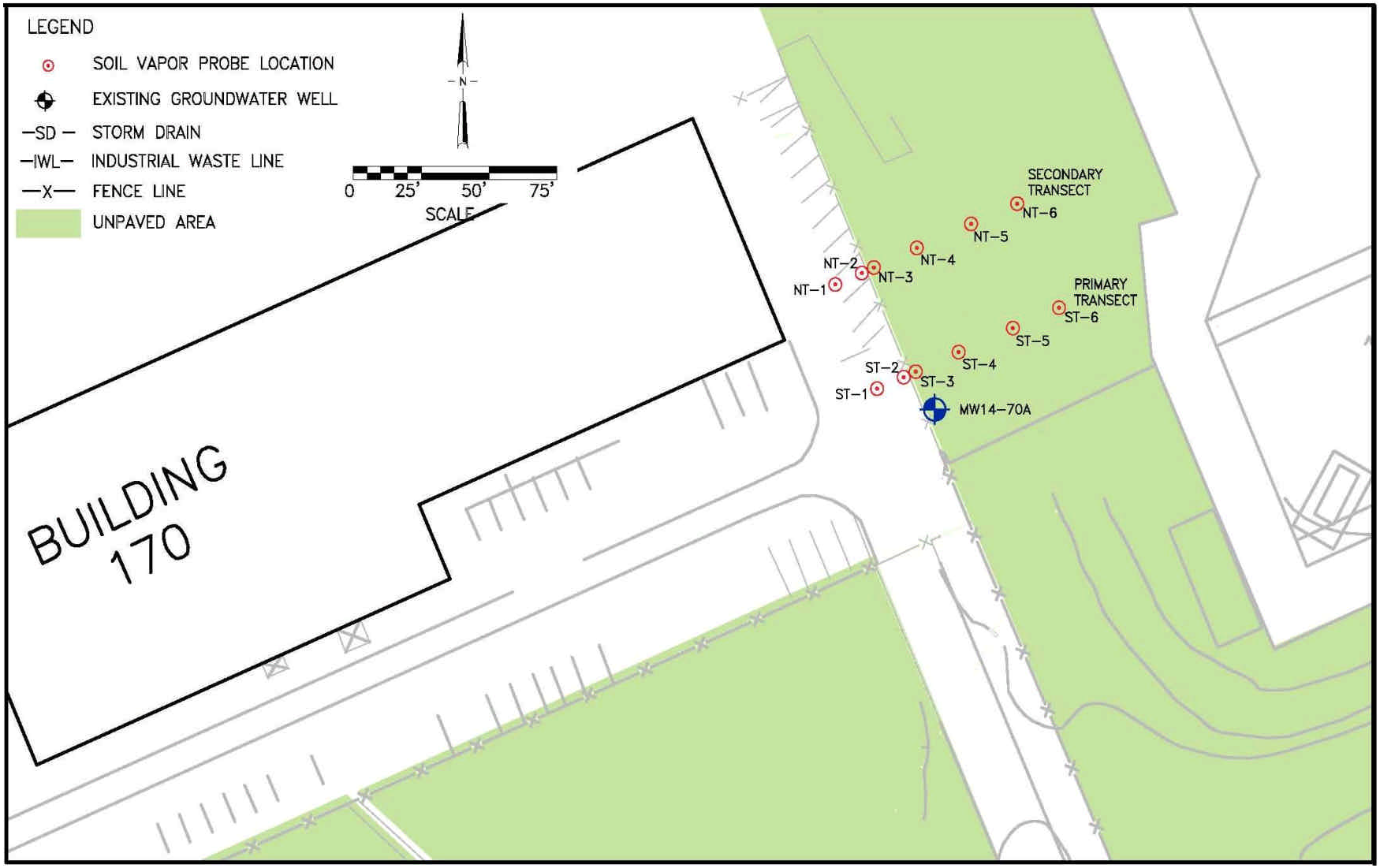

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Methods

- Multiple soil gas probes were installed at each sampling location along the transect
  - depths of 2, 4, 7 and 10 feet
  - immediately sub-slab at ST-1 and ST-2
- Grab soil gas samples collected in a syringe from each probe and analyzed for TCE/PCE by EPA Method 8021
- To generate the soil gas profile, two or three samples were taken over a 3 day period and results averaged
- Grab samples of surface groundwater were collected at selected boreholes

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Layout of Soil Gas Sampling Probes

Schematic of Nested Soil Gas Probes

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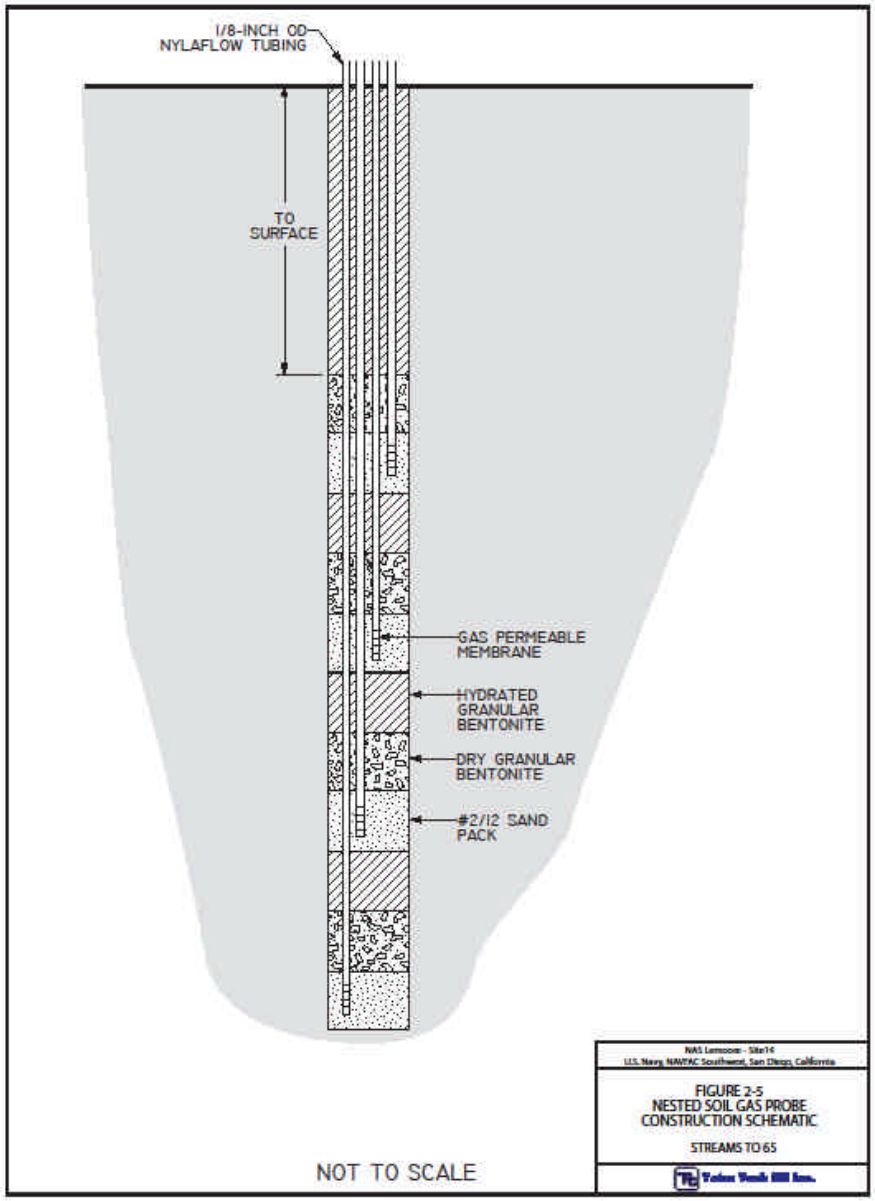

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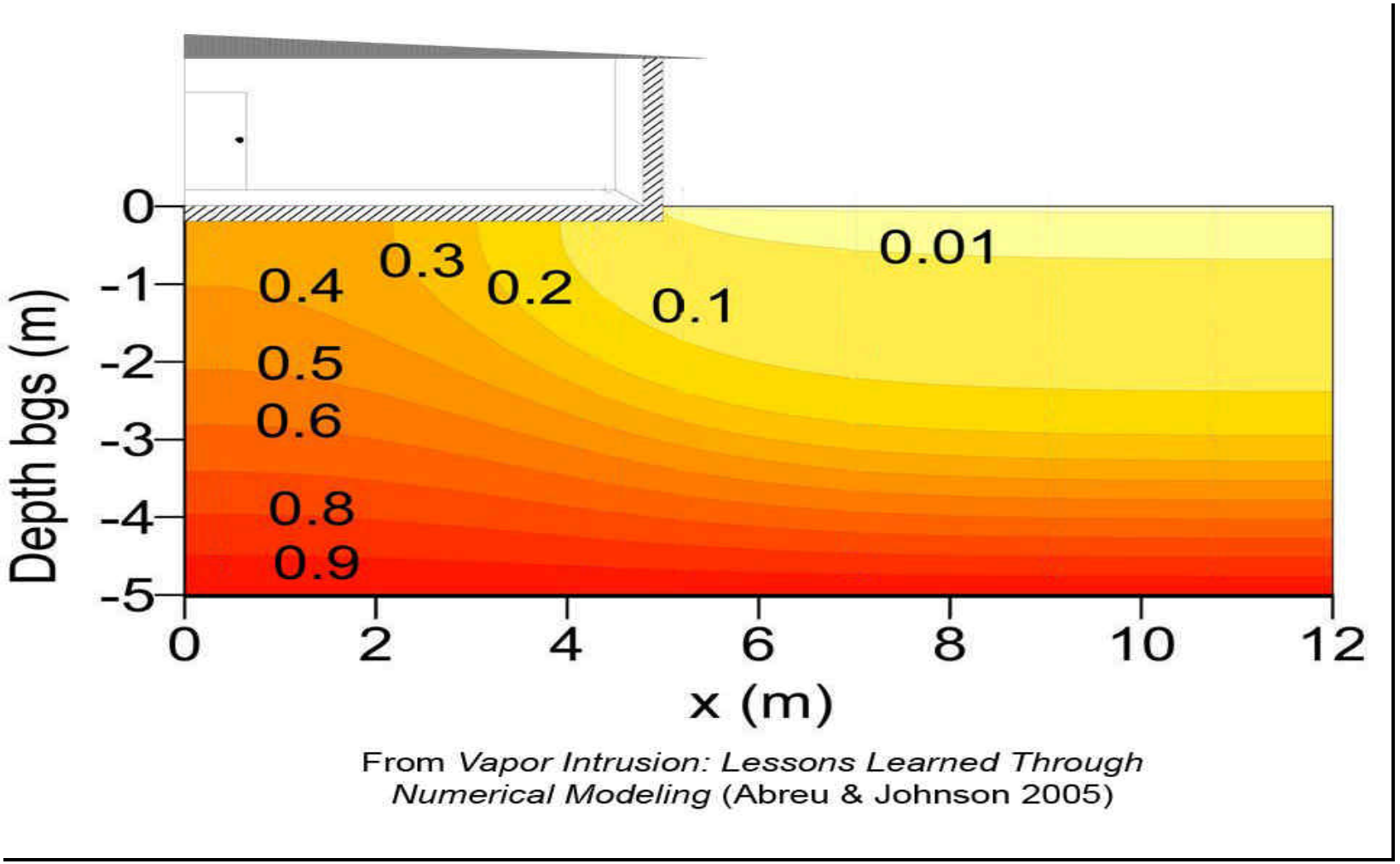
Example Model Predictions for a Soil Gas Profile



From *Vapor Intrusion: Lessons Learned Through Numerical Modeling* (Abreu & Johnson 2005)

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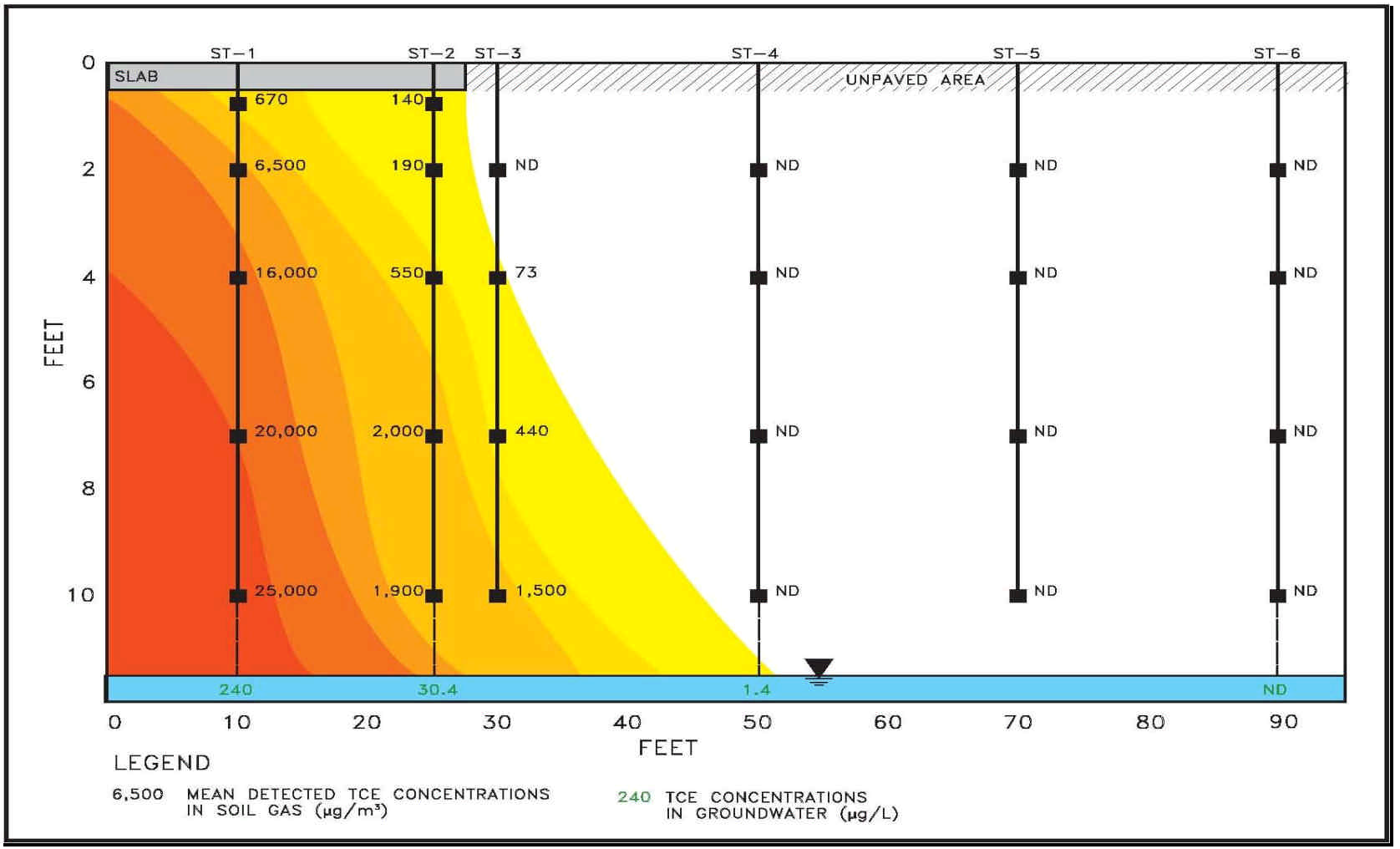
Measured Soil Gas Profile for TCE



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Observations Regarding the Soil Gas Profile

- The profile was generally consistent with physical principles and model predictions
  - soil gas concentrations decrease moving horizontally out from underneath and away from the slab
  - soil gas concentrations decrease with increasing distance from the groundwater source

- The isoconcentration contours were steeper than model predictions with a uniform groundwater concentration
  - groundwater concentrations decline too
  - soil gas concentrations near the water table about 20% of Henry's Law equilibrium

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Possible Reasons for Steep Slope in Soil Gas Profile

- Source is clearly finite (groundwater concentrations are not constant)
- Groundwater is relatively shallow
- Large building with limited exposed ground surface for vapor release
- Plume at this site is mature and possibly receding
- Possible variations in source strength and other site-specific factors

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Conclusions

- Strong soil gas concentration gradients exist in the near-slab environment
  - horizontal gradients exist to move VOC mass out from underneath the slab
  - vertical gradients exist to move VOC mass up toward uncovered soil
- There are gradients in groundwater concentration and across the water/soil gas interface as well
- Soil gas and groundwater concentrations in the near-slab environment are in a state of dynamic equilibrium

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Implications for Near-Slab Sampling and Modeling

- Near-Slab Soil Gas Sampling
  - Near-slab soil gas measurements not easily correlated with sub-slab concentrations
  - If near-slab samples must be taken, take them as close to the edge of the slab as possible

- Modeling
  - Simplifying assumptions, such as constant groundwater concentrations, may not apply to the near-slab environment
  - Different mechanisms limit mass transfer near-slab vs. sub-slab

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Future Research

- Long-term Investigations of the Soil Vapor Profile at NAS Lemoore IRP Site 14
  - Monthly sampling of soil vapor probes
  - Additional soil vapor probes to “fill in” data gaps
  - Groundwater sampling at each probe location

- Impact of Sampling & Temporal Variables on Soil Gas Results
  - Continuous soil gas monitoring during major storm
  - Impact of purge volume
  - Different tubing types

Location of Sampling Transects

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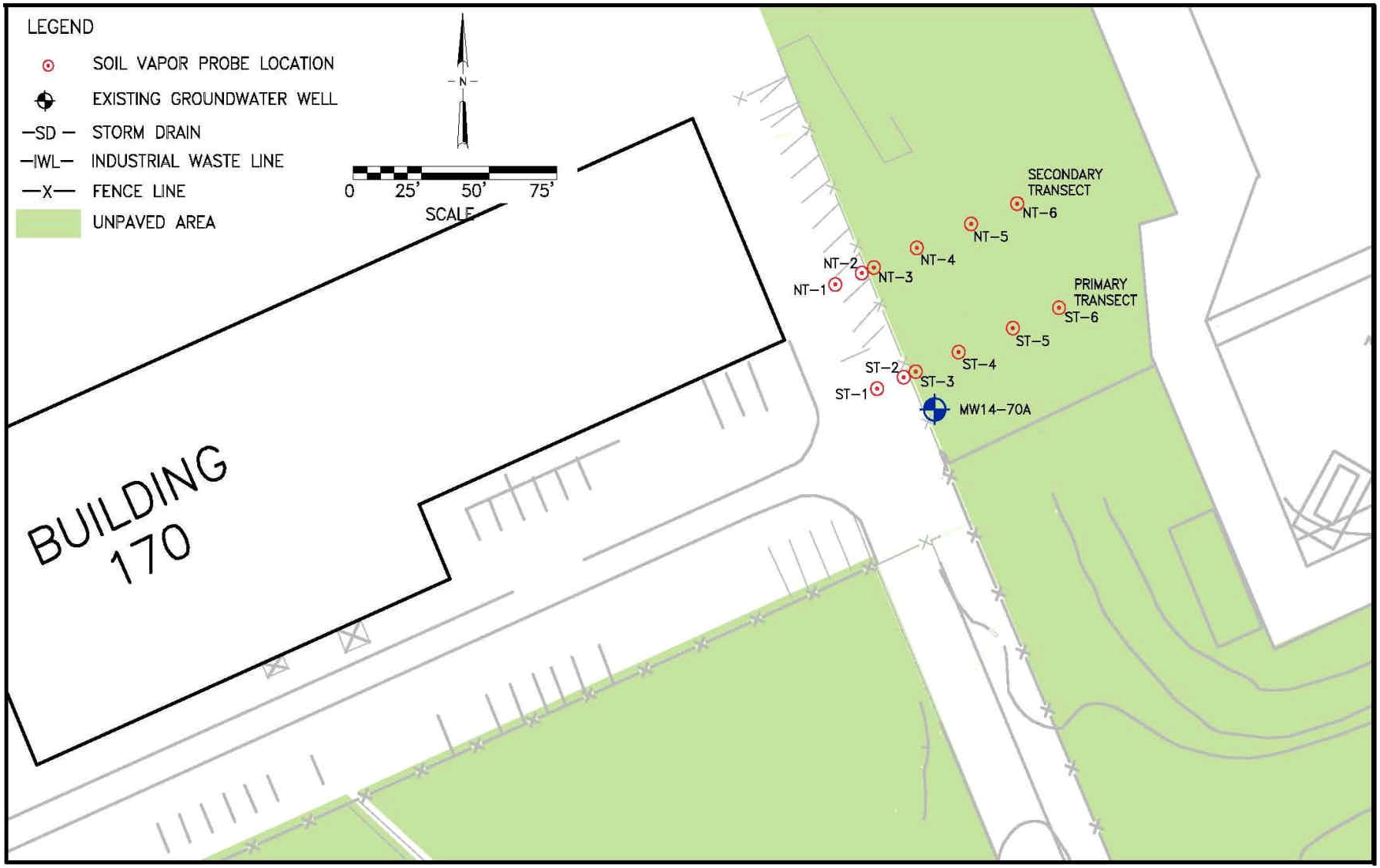

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Measured Soil Gas Profile for TCE